WE CLAIM:

1. High-speed method of depositing diamond films from the gaseous phase in the plasma of a microwave discharge, when the microwave discharge is formed in the gaseous mixture placed in the reaction chamber and consisting of at least hydrogen and hydrocarbon, the said gaseous mixture is activated by means of a microwave discharge to form atoms of hydrogen and carbon-containing radicals, and the latter are deposited on the substrate and form a polycrystalline diamond film as the result of surface reactions, which differs in that the said gaseous mixture is activated by means of increasing density of electrons, Ne, in the plasma by means of creating stable non-equilibrium plasma with its power at least 1 kW and frequency f that exceeds by far the frequency of 2.45 GHz, which is used commonly, in the reaction chamber, and, in order to localize the plasma, a standing wave near the substrate is formed and at its nodes plasma layers with the possibility to control their dimensions are generated and maintained.

2. High-speed method as described in par. 1, which differs in that the said gaseous mixture is activated by means of increasing electron density Ne by using electromagnetic radiation with its frequency f equal to 30 GHz, and the dimensions of the plasma layers in the nodes of the standing microwave are controlled by changing the profiles and size of the transverse cross-section of the crossing wave beams that form the standing wave.

3. High-speed method as described in par. 1 or par. 2, which differs in that four or more wave beams that are crossed pairwise are used to form the standing wave.

4. High-speed method as described in par. 1 or par. 2, which differs in that two converging crossing wave beams are used to form the standing wave.

5. High-speed method as described in par. 1 or par. 2, which differs in that two converging opposite wave beams are used to form the standing wave.

6. High-speed method as described in par. 1 or par. 2, which differs in that the wave beam incident on the substrate and the wave beam reflected from the substrate are used to form the standing wave.

7. Plasma reactor for high-speed deposition of diamond films from the gaseous phase in the plasma of a microwave discharge, which contains a microwave generator, a transmission line ending with a quasi-optical electrodynamic system, a reaction chamber with a substrate on a substrate holder placed in it, and a system for pump-in and pump-out of the selected gaseous mixture, which differs in that the quasi-optical electrodynamic system is made and installed such as to make it possible to form a standing microwave in the area selected in the vicinity of the substrate, and the transmission line is made as an oversized circular waveguide with corrugation of its internal surface, which is supplemented with a mirror system to transfer at least one Gaussian beam to the said quasi-optical electrodynamic system.

8. Plasma reactor as described in par. 7, which differs in that the quasi-optical system is made of four mirrors situated on different sides relative to the region of plasma formation and installed in order to make it possible to direct the microwave radiation as four wave beams crossing pairwise, and the quasi-electrodynamic system together with a part of the transmission line are installed within the reaction chamber, and the transmission line is supplemented with a divider, which divides one wave beam into four beams and is installed at the output of the said oversized circular waveguide.

9. Plasma reactor as described in par. 7, which differs in that the quasi-optical system is made of two mirrors situated on different sides relative to the region of plasma formation and installed in order to make it possible to direct the two beams of the microwave radiation at small angles to the substrate surface, and the transmission line is supplemented with a divider, which divides one wave beam into two beams and is installed at the output of the said oversized circular waveguide.

10. Plasma reactor as described in par. 7, which differs in that the quasi-optical system is made of two mirrors situated on different sides relative to the region of plasma formation and installed in order to make it possible to direct the wave beams opposite to each other, and one of the two mirrors is installed so as to be movable forward and backward parallel to itself to the distance of $\pm\lambda/4$, where λ is microwave radiation wavelength, and the transmission line is supplemented with a divider, which divides one wave beam into two beams and is installed at the output of the said oversized circular waveguide.

11. Plasma reactor as described in par. 7, which differs in that the bottom part of the reaction chamber has a dielectric window to inject microwave radiation, and the substrate is installed in the top part of the chamber opposite to the window, and the quasi-optical electrodynamic system is made as one mirror situated out of and lower than the said reaction chamber so as to make it possible to direct the microwave beam upwards perpendicular to the substrate surface.

12. Plasma reactor as described in par. 7, which differs in that the quasi-optical electrodynamic system is made as one mirror installed so as to make it possible to direct the microwave beam with normal incidence to the substrate surface or at a low angle to the normal, and a cooled radioparent wall is installed in the reaction chamber, which wall is made as a grating of thin cooled metal tubes or rods and is installed parallel to the substrate at the distance longer than $\lambda/2$ from the substrate.

13. Plasma reactor as described in par. 7, which differs in that the quasi-optical electrodynamic system is made as a mirror and a quasi-optical resonator with plane-parallel mirrors set at the distance multiple of $\lambda/2$, which resonator is coupled with the electrodynamic system, and one of the resonator mirrors is a substrate on the substrate holder, and the other mirror is made as a periodic grating of thin metal tubes or rods, and the grid period is less than λ.

14. Plasma reactor as described in par. 8 or par. 9, or par. 10, which differs in that the system for pumping gas into the reaction chamber into the region of plasma formation is made as a concave metal screen with a feeding tube in its central part, and this screen is situated over the substrate holder at an adjustable distance, and the system for pumping the gas out is made as a set of apertures in the substrate support, which has some volume for the evacuated gas mixture, and in this volume the system for water cooling of the upper part of the substrate support is situated.

15. Plasma reactor as described in part. 12 or par. 13, which differs in that the system for pumping the selected gas mixture in is combined with the grating made of thin cooled metal tubes, and the system for pumping the gas out is made as a set of apertures in the substrate holder, which has some volume for the evacuated gas mixture, and in this volume the system for water cooling of the upper part of the substrate holder is situated.